THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND COMMUNICATIONS ENGINEERING

FIRST SEMESTER EXAMINATION (2021)

EE315 ELECTRICAL POWER SYSTEMS I

THIRD YEAR ELECTRICAL ENGINEERING – POWER (BEEP 3)

TIME ALLOWED: 3 HOURS (20 MINUTES CLOSED BOOK)

INFORMATION FOR STUDENTS

1. **QUESTION ONE** is **CLOSED BOOK QUESTION**. Use the **FIRST ANSWER BOOK** to answer this. Time allowed is **20 MINUTES**.

2. **QUESTIONS TWO to FIVE** are **OPEN BOOK QUESTIONS**. All answers must be written in the **SECOND ANSWER BOOK** supplied.

3. There are five (5) questions. Marks per question are indicated

4. COMPLETE THE DETAILS REQUIRED ON THE FRONT COVER OF YOUR ANSWER BOOK – **DO THIS NOW and SIGN** on the space provided.

5. Complete the details in Examination Slip provided. **DO THIS NOW** and **SIGN** on the space provided.

6. Only drawing instruments, calculators and laptops with textbooks are permitted on your desk.

7. Mobile phones are **NOT** permitted. All phones are to be **SWITCHED OFF**.

8. If you are found cheating in the Examination the penalties specified by the University shall apply.

9 You have **TEN (10) MINUTES** to read the paper.

   You must not begin writing during this time.

CLOSED BOOK QUESTION

QUESTION ONE (20 marks)

(a) Discuss the functions of the following protection equipment:

    (i) Current Transformers.
    (ii) Potential Transformers,
    (iii) Relays, and
    (iv) Circuit breakers.

(b) Show the schematic diagram of relay connections to protect the following components against excessive currents that result during faults using differential relays:

    (i) transformer winding protection,
    (ii) busbar protection.

Label all components.

QUESTION TWO   (20 marks)

A three-phase star-connected 50 Hz generator 240 V per phase and supplies three-delta-connected load coils having resistance of 10 Ω and an inductance of 47.75 mH.
Determine:
- (a)   The line voltage and line currents,
- (b)   The load current,
- (c)   The total real power and reactive power dissipated by the load,
- (d)   The value of the three capacitors required to correct the overall power factor to unity. Assume the capacitors are star-connected for power factor corrections.

QUESTION THREE   (20 marks)

A generator G_1 and is connected to a transformer T_1 which in turn is connected to a transmission line L. At the receiving end of the line is connected a transformer T_2, the secondary of which is connected to a motor load M.

The equipment ratings are given below:
     G_1: 60 MVA, 20V, X= 0.09 p.u
     T_1: 50 MVA, 20/200 kV, X= 0.1p.u
     T_2: 50 MVA, 200/20 kV, X= 0.1p.u
     Line (L): 200 kV, 120 + j200 ohms
     Motor Load (M): 43.2 MVA, 18 kV, 0.08 p.u

Draw a per unit impedance diagram showing all impedances in per unit on a 100 MVA base. Choose 20 kV as the voltage base of the generator.

QUESTION FOUR   (20 marks)

A single-circuit 3-phase, 60 Hz transmission line consists of three conductors 1, 2, and 3 each of diameter 2 cm. The spacing between the conductors are $D_{12} = D_{13} = 5$ m, and $D_{23} = 8$ m. Assume a transpose line.

(a) Derive the voltage drop equations for each phase
(b) Find the inductive reactance of the line per km per phase.

QUESTION FIVE   (20 marks)

A three-phase, single-conductor overhead line has solid cylindrical copper conductors with 1.5 cm radius. The conductors are arranged in a horizontal configuration with 5 m spacing. Calculate the capacitance-to-neutral in F/m and the admittance-to-neutral in S/m. Neglect the effect of earth plane.